

The Institute of Physics
BULLETIN

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*The Bulletin is published by The Institute of
Physics for circulation to its members.*

Notices to Members

Institute's archives

To complete some sets for binding the Secretary requires a few copies of the following :—

Annual Reports for 1922 and 1944

Notes and Notices (the predecessor of the *Bulletin*) for July 1948 and July 1949.
Can any member oblige, please ?

Subscriptions

Increase of subscriptions. The attention of members is particularly drawn to the report of the Extraordinary General Meeting (page 259) when approval was given for the increase of the subscriptions payable by Fellows, Associates and Graduates over the age of 25 and Subscribers as from January 1, 1959.

Payment of subscriptions. Members are reminded that subscriptions become due on January 1 and that a form to be sent with remittances is published each year in the January *Bulletin*. They are asked not to send subscriptions for 1959 until the form is issued in January. Members who pay by banker's order have already been notified of the changes.

Association for Radiation Research

At the Seventh Meeting of the Radiation Research Visiting Club the decision was taken to form an Association for Radiation Research, its objects being :—

- To bring together research workers of different disciplines, having a common interest in radiobiology, radiation chemistry and radiation physics ;
- To establish and maintain liaison nationally and internationally with bodies having similar and related interests.

The first Committee is as follows :—*Chairman*: Dr. L. H. Gray; *Honorary Secretary*: Miss T. Alper; *Honorary Treasurer*: Dr. C. L. Smith; *Ordinary members*: Prof. A. Charlesby, Prof. F. S. Dainton, Dr. Alma Howard, Dr. J. F. Loutit, Prof. J. S. Mitchell, Dr. Edith Paterson.

Anyone wishing to join the Association should be proposed and seconded by members who know them personally. Application forms may be

obtained from Miss T. Alper, F.Inst.P., the Honorary Secretary, Association for Radiation Research, Experimental Radiopathology Research Unit, Hammersmith Hospital, Duane Road, London, W.12.

Specialist Discussion Meetings on New Digital Computer Techniques

The Committee of the Measurement and Control Section of the Institution of Electrical Engineers are arranging for Specialist Discussion Meetings on new digital computer techniques to be held in the Institution building in London, on February 16 and 17, 1959.

The meetings are intended for specialist, rather than for popular discussion and will cover the electrical engineering aspects of digital computers. The uses of computers will not be discussed except where a particular use has given rise to new design problems.

It is intended to deal with the following subjects:—

1. Character recognition ;

2. Peripheral Equipment (magnetic tape, paper tape, fast printers, and other forms of input and output devices ; and problems arising in their attachment to digital computers) ;
3. Low Temperature Storage and Switching Devices ;
4. Special Aspects of Logical Design, for example logical circuit techniques, fast carry logic for adders, interrupt facilities and the relation of logical design to reliability.

The Committee will be pleased to consider offers of contributions which if selected, will be included in the program. Anyone wishing to submit a contribution for consideration should send a synopsis of the subject matter which would be covered, to the Secretary of the Institution of Electrical Engineers, Savoy Place, London, W.C.2, as soon as possible.

The meetings will be open to members and non-members of the Institution, and particulars of the registration and other fees will be announced in due course.

Proceedings of the Thirty-eighth Annual General Meeting

THE Thirty-eighth Annual General Meeting of the Institute was held on July 1, 1958, in the Institute's house. Mr. O. W. Humphreys (President) was in the Chair. A quorum being present, the Secretary read the notice convening the meeting. The Minutes of the previous Annual General Meeting held on July 12, 1957, were approved and signed.

Arising from the Minutes the Secretary thanked the members for good wishes for his recovery from illness, which had been conveyed to him after the last Annual General Meeting and he expressed his appreciation of the way in which the Institute's work had been carried on by his colleagues in his absence.

Mr. N. Clarke (Fellow) and Mr. T. W. Lindop (Associate) were appointed scrutineers of the ballot for election to the Board and for election to Honorary Fellowship.

On the proposal of Dr. J. Taylor (Treasurer), seconded by Mr. G. W. Warren (Fellow), it was unanimously resolved that the accounts and balance sheets for the year ending December 31, 1957, be adopted. Professor F. A. Vick (Honorary Secretary) moved the adoption of the report of the

Board for 1957 and this was seconded by Mr. R. M. Sillitto (Fellow). The resolution was carried unanimously.

The President, having received the scrutineers' report, announced that those nominated by the Board had been duly elected to fill the vacancies which would occur on September 30, 1958 ; these were :

President :	Sir George Thomson
Vice-President :	Dr. R. W. Sillars
Honorary Treasurer :	Dr. J. Taylor
Honorary Secretary :	Professor F. A. Vick
Ordinary Members of the Board :	Dr. A. C. Menzies and Dr. J. Topping

Having received the scrutineers' report the President declared Sir Lawrence Bragg duly elected an Honorary Fellow of the Institute.

Messrs. Knox, Cropper & Co. were elected auditors for the year 1958.

Votes of thanks were moved to the President, Honorary Officers and members of the Board, the Honorary Officers of Branches and Groups and the bodies which have allowed the use of their rooms during the year for meetings. These were carried with applause.

Proceedings of Extraordinary General Meeting

NOTICE OF CHANGE IN BY-LAWS REGARDING SUBSCRIPTIONS

An Extraordinary General Meeting of the Institute was held on September 10, 1958, at the Institute's house. Mr. O. W. Humphreys (*President*) was in the Chair. A quorum being present the Secretary read the notice convening the meeting. Dr. J. Taylor (*Honorary Treasurer*) proposed and Lt.-Col. H. S. Young (*Fellow*) seconded the following five resolutions:—

Resolution 1: That By-law 15(b) be rescinded and that the following be substituted therefor:

"Save as hereinafter provided, each Fellow shall pay an entrance fee of five guineas and an annual subscription of six guineas, but a Fellow transferred from the class of Associate shall pay a transfer fee of three guineas in lieu of entrance fee and a Fellow who, as Associate, compounded his annual subscription as Associate shall pay an annual subscription of two guineas.

Each Fellow permanently resident abroad shall pay an annual subscription of three and one half guineas, unless, as Associate, he compounded his annual subscription as Associate when he shall pay an annual subscription of one guinea."

Resolution 2: That By-law 15(d) be rescinded and that the following be substituted therefor:

"Save as hereinafter provided, each Associate shall pay an entrance fee of two guineas and an annual subscription of four guineas.

Each Associate permanently resident abroad shall pay an annual subscription of two and one half guineas."

Resolution 3: That By-law 15(e) be rescinded and that the following be substituted therefor:

"Notwithstanding the provisions of these By-laws the amounts of the annual subscriptions payable by Members which became due before 10 September, 1958, shall for the year 1958 be in accordance with By-law 15 as adopted on 15 September, 1949."

Resolution 4: That By-law 21(c) be rescinded and that the following be substituted therefor:

"Save as hereinafter provided, each Graduate shall pay an entrance fee of one guinea and an annual fee of three guineas if he be over twenty-five years of age and of two guineas if he be under that age, but a Graduate transferred from the class of Student shall pay a transfer fee of half a guinea in lieu of entrance fee provided that he has been a Student of the Institute for at least one year.

Each Graduate permanently resident abroad shall pay an annual fee of one and one half guineas if he be over twenty-five years of age and of one guinea if he be under that age.

The change in the rate of subscription consequent upon the attainment of the age of twenty-five years shall take effect from the first day of January next following the day on which that age is attained."

Resolution 5: That By-law 24 be rescinded and that the following be substituted therefor:—

"Each Subscriber shall pay an annual fee of three guineas unless he be permanently resident abroad when he shall pay an annual fee of one and one half guineas. A Subscriber shall not be required to pay any entrance fee."

In accordance with Article 77 the Chairman demanded a poll on each resolution. Lt.-Col. H. S. Young (*Fellow*) and Mr. E. W. L. Leavey (*Associate*) were appointed scrutineers; it was reported that 715 members had appointed Dr. H. R. Lang as their proxy, the instruments of appointment having been duly deposited at the Institute's offices forty-eight hours before the meeting.

On receiving the scrutineers' report the Chairman declared the resolutions carried and announced the result of the polls to be:

	<i>For</i>	<i>Against</i>
Resolution 1 ...	670	55
2 ...	667	58
3 ...	678	45
4 ...	670	54
5 ...	674	48

The notice convening the Extraordinary General Meeting, circulated only to Fellows and Associates resident in Great Britain, was accompanied by an explanatory memorandum and a covering letter from the President inviting the support of members for the Board's proposals. The following is the main part of the memorandum circulated:

"In each April issue of the *Bulletin* for the past few years members have been given a general picture of the Institute's financial position in a set of consolidated accounts with comments on them. They will have seen that 1957 ended with a deficit of nearly £3,000 and that, as stated in the June issue of the *Bulletin*, it now appears that a deficit of about the same amount is likely in 1958; also that the Institute's liquid reserves correspond to less than a tenth of the annual expenditure. 'The

principal cause of this unhappy position is of, course, the continued decrease in the purchasing power of the pound.

As members were informed at the time, it was realized that because of changing conditions, the changes in prices and arrangements for the distribution of the *Journals* made in 1955, which increased the Institute's income by some £4,000 a year, might not safeguard our financial position for more than a few years. The annual consultative meeting of Honorary Officers of the U.K. Branches and Groups held that year informed the Board that it recognized that members must eventually bear some share of the increase in costs the Institute had to face, but "hoped that it would be felt possible to postpone any increase of charges to members until January, 1957." The last increase in subscription rates was nine years ago.

Almost every item on the expenditure side has increased considerably during the past three years. The increase in the cost of producing the *Journals* has absorbed a part of the higher revenue resulting from the new prices introduced in 1955. There has also been a drop in advertisement revenue during the past two years, which may continue despite special efforts to improve the position. The cost of the staff (including the publications staff) has risen from £14,000 in 1955 to £21,000 this year. In spite of the growth of the Institute's activities in all directions the present staff consists of only thirty-four persons (six more than in 1955). No staff could be more loyal and hard-working but, without further increases in our expenditure, the efficiency of headquarters cannot be maintained. It will be appreciated that apart from increases in National Insurance and pension contributions, salaries and wages must be kept reasonably in line with those obtaining elsewhere if we are to retain and recruit suitably qualified staff.

The growth of membership, while very satisfactory, has increased the income by only about £3,000 p.a. since 1955.

Your Board has now decided to increase the retail price of the annual volumes of both the *Journal of Scientific Instruments* and the *British Journal of Applied Physics* from £5 to £6 from January next, and to increase the price of single copies from 10s. to 12s. 6d. (the last increases were from £4 to £5 per volume for *J.S.I.* in 1956 and for *B.J.A.P.* in 1957). Members of all grades will be entitled to subscribe to either *Journal* for their personal use at £1 10s. per volume or, if they take both, at £2 10s. for the two volumes. This simplifies the present complicated arrangements for different grades and represents an increase of

about 5s. per volume in most instances. These changes are expected to yield an additional £5,000 p.a. It is the Board's intention to use part of this increase to improve the *British Journal of Applied Physics*, the development of which has been limited by funds available.

To bridge the gap still remaining an increase in subscriptions is inevitable. When the Board considered the report of the small committee which it set up to look into the Institute's finances, some members felt that the increases in subscription rates should be large enough to provide a reasonable margin to cover the further inflation which might take place during the next few years. It was, however, agreed to keep the increases as low as possible. The new rates which are expected to yield an additional income of about £3,000 p.a., are set out below, the present rates being shown in brackets. Subject to the passing, at the Extraordinary General Meeting, of the resolutions set out on p. 2, the new rates will become effective on January 1, 1959.

	Resident in U.K.		Resident overseas	
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Fellow	6 6 0	(5 5 0)	3 13 6	(3 3 0)
Associate	4 4 0	(3 3 0)	2 12 6	(2 2 0)
Graduates:				
Over 25	3 3 0	(2 2 0)	1 11 6	(1 1 0)
Under 25	2 2 0	(2 2 0)	1 1 0	(1 1 0)
Student	10 6	(10 6)	5 0	(5 0)
Subscriber	3 3 0	(2 2 0)	1 11 6	(1 1 0)

The special concessions (made by the Board under By-law 19) for Graduates and Students serving their term of National Service will be continued as well as those for Subscribers under 21 years of age who are in *statu pupillari*.

Provision is made for the twelve Fellows who compounded as Associates to continue to pay only the difference between the Associate's and Fellow's subscription in accordance with the Board's decision of November, 1955, when its attention was drawn to the anomaly in the present By-law.

Members will know from the June issue of the *Bulletin* that the Finance Bill now before Parliament provides for subscriptions to "approved" bodies to rank for expenses for Schedule E income tax purposes and it is hoped that the Institute will be among the bodies approved by the Commissioners for this purpose.

Your Board is fully aware that the increased subscription rates may be hard on some of the older members of long-standing who have retired from professional work. It reminds them that the Board has power to reduce fees in special instances and the Treasurer, acting on its behalf, is always prepared to consider such cases."

MESSAGE FROM MR. O. W. HUMPHREYS

(Immediate Past-President)

Mr. Humphreys who, as President, signed a personal invitation to members to support the proposals, writes:—

"I would like to thank the large number of members who responded to my personal invitation to vote on the resolutions submitted to the Extraordinary General Meeting on September 10 last, the details of which are formally set out above.

It is never pleasant to have to recommend members to increase their fees. The overwhelming support which the Board's proposals received reflects the keenness of the interest of members in the expanding activities of the Institute and their understanding of the problems imposed by the continual decrease in the value of money: it will be a great encouragement to those elected to manage the Institute's affairs."

O. W. HUMPHREYS, 30.9.58.

Benevolent Fund

Of some 3,500 corporate members, only about 1,250 contribute to the Benevolent Fund, and, of these, only about 40 do so under seven-year Covenants on which income tax is recoverable by the Fund. The Committee wishes to point out that grants from the Fund now amount to over £500 p.a., having doubled in the last five years, and it is anxious to build up its slender capital reserves to enable it to meet further increases in the number of requests for assistance, including those from members who may find themselves temporarily unemployed at some time in the future. It hopes, therefore, that many more Fellows and Associates will contribute to the Fund under seven-year Covenants for at least half-a-guinea a year in order that it may recover income tax in accordance with the following table calculated at the present standard rate of 8s. 6d. in the pound.

Your net annual contribution	Value of contribution after addition of tax recovered by the Fund	Total value to the Fund of the 7-year Covenant
£ s. d.	£ s. d.	£ s. d.
10 6	18 3	6 7 2
1 1 0	1 16 6	12 15 6
2 2 0	3 13 1	25 11 7
3 3 0	5 9 7	38 7 1
5 5 0	9 2 7	63 18 1

Contributions made in this way will thus be worth considerably more to the Fund, without extra cost to members. If you, who read this, are prepared in this way to assist those of our members and their dependents who have met with misfortune, please complete the Deed of Covenant on page of this issue of the *Bulletin* and return it to the Secretary at your early convenience. Do **not** send any money with it, but include the annual net contribution with your annual subscription at the beginning of next year. A reminder of this will be included in the annual subscription notice which will, as usual, be issued with the January *Bulletin*. (Those members who are good enough to pay their annual subscription by Bankers' order will already have received this appeal.) Headquarters will take the necessary steps to complete the legal formalities before the first payment under these Covenants become due.

The Secretary will be glad to answer any points about the Covenant scheme or about the Fund on which members would like further information.

Australian Geophysical Research in Antarctica

By PHILLIP LAW, M.Sc., F.Inst.P.

(Director, Antarctic Division, Department of External Affairs, Australia)

IN 1947 the Australian Government set up the Australian National Antarctic Research Expeditions (A.N.A.R.E.) under the Department of External Affairs to carry out a programme of exploration and scientific research in Antarctica and on Heard Island and Macquarie Island in the sub-Antarctic. For various reasons it was not possible for the A.N.A.R.E. to set up an Antarctic station in 1947-48; however, the Heard Island station ($53^{\circ} 06'S$, $73^{\circ} 30'E$) was established in December, 1947, and that at Macquarie Island ($54^{\circ} 30'S$, $158^{\circ} 57'E$) in March, 1948. The Macquarie Island station is still operating but the Heard Island establishment was closed down in March, 1955.

In February, 1954, a new station was established at Mawson ($67^{\circ} 36'S$, $62^{\circ} 52'E$) and in January, 1957, a further observation post was installed at Davis ($68^{\circ} 34'S$, $77^{\circ} 58'E$). The three stations—Mawson, Davis and Macquarie Island—are participating in the Australian program for the International Geophysical Year.

When plans were being made in 1947 for setting up stations at Heard Island and Macquarie Island it was arranged that the work would comprise meteorology, geology, biology and cosmic rays. However, from 1949 onwards, these stations were developed as geophysical observatories and, even before the I.G.Y. was mooted, they were already carrying out elaborate geophysical programmes. For example, in 1953 their studies and facilities included the following:

Macquarie Island:—An "A" Class weather station with daily radiosonde measurements and three-hourly synoptic observations; recording seismographs; absolute geomagnetic observations and continuously recording magnetic variometers; cosmic ray meson telescopes recording time variations of intensity; visual auroral observations for the study of auroral morphology; vertical ionospheric soundings;

Heard Island:—An "A" Class weather station with daily radiosonde measurements, three-hourly synoptic observations and radiotheodolite for determining upper winds; geomagnetism and seismography as for Macquarie Island; gravity measurements.

Mawson Station commenced operations in 1954 with a restricted programme of meteorology, geology and surveying, but in 1955 the programme was extended to include cosmic ray measurements, geomagnetic observations and visual auroral observations.

The process of elaborating and adding to the geophysical equipment at the A.N.A.R.E. Stations continued in 1956 and 1957 until, at the present time, the I.G.Y. programme at the various stations is that set out below. Details of the yearly developments since 1948 have been given in a series of articles by the author in the *Polar Record*, the journal of the Scott Polar Institute, Cambridge.

I.G.Y. PROGRAMME OF THE A.N.A.R.E.

MAWSON

Meteorology:—Surface observations are made three-hourly; radiosonde, daily; upper wind measurements using radiosonde balloon and radio-theodolite, twice daily. Radiation is recorded continuously over the ice near Mawson for study of the radiation balance over the ice sheet.

At Taylor Station, about 50 miles west of Mawson (occupied during the winter months) surface observations and pilot balloon flights are made at six-hourly intervals. Similar observations are made by field parties as opportunity arises and from the expeditions' ships during their antarctic voyages.

Research is being conducted on the capability of forecasting in the Mawson area, evaluation of antarctic analysis for use in the Mawson area, characteristics of weather systems, meteorological factors affecting aviation and abnormal refraction.

A meteorologist from the Commonwealth Bureau of Meteorology is attached for one year to the "Weather Central" at Little America, where he will study problems of the general circulation over Antarctica and the Southern Ocean.

Radiophysics:—Vertical ionospheric soundings are made, using automatic equipment which sweeps the frequency range 1-25 Mc/s every ten minutes.

Winds in the 80 Km region are determined by automatically tracking the drift of meteor ionization trails by radar.

Aurora :—The distribution of auroras is recorded by automatically photographing the whole sky at five-minute intervals during the dark hours. These records are supplemented by visual observations. Accurate determinations of position of auroras are made by parallax photography using two phototheodolites at the ends of a 50-mile base line (Mawson and Taylor). These observations are used in a general study of auroral morphology.

Geomagnetism :—La Cour magnetographs record the slower variations in geomagnetic field components. Induction variographs have been set up to record rapid fluctuations (period of order 0.1 to 10 sec.).

Absolute magnetic measurements are made about once per week at Mawson; also, as opportunity arises, at a number of points along the Antarctic coast line accessible from the expeditions' ships and at inland points accessible to aircraft or ground parties.

Glaciology :—Using seismic sounding methods and gravity determinations, a survey is being made to determine the thickness of ice burden and to define the sub-glacial topography of the Antarctic Plateau in the region accessible from Mawson. One traverse 400 miles long has already been completed in a direction south of Mawson. Incidental measurements are underway to determine the variation of seismic velocity with depth, the direction of glacial flow, crystal orientation, etc.. A general study of the mass economy and heat exchange of the ice cap is being undertaken. This involves measurements of accumulation, wind, transport of snow, ablation, flow, and density and temperature distribution over the surface and as a function of depth.

Seismology :—A three-component seismograph was installed early in 1957 but continued instrument trouble has delayed the full recording programme. The vertical component is operating.

Gravity Observations :—Gravity observations have been made at Mawson and at a number of coastal and inland points in Australian Antarctic Territory. This work continues as opportunity arises. Gravity ties have been made between Melbourne, Mawson, Mirny (U.S.S.R. station) Heard Island, Iles de Kerguelen (French station) and Macquarie Island.

Cosmic Rays :—Time variations in the meson components are recorded with two $100\text{ cm} \times 100\text{ cm} \times 100\text{ cm}$ geiger counter telescopes, each

capable of pointing in any direction. Also, the neutron component is recorded with a 12-counter lead-paraffin pile.

DAVIS

Meteorology :—Surface observations are made at three-hourly intervals and pilot balloon flights twice daily.

Aurora :—An automatic all-sky camera similar to that at Mawson is maintained.

LEWIS ISLET

At Lewis Islet (about 1,700 miles east of Mawson) an automatic station (measuring wind speed and direction, dry bulb temperature and atmospheric pressure) was established in January, 1958, which it is hoped will continue to operate unattended for twelve months. It broadcasts readings every six hours.

MACQUARIE ISLAND

Meteorology :—Surface observations are made three-hourly; radiosonde daily; upper winds by radar tracking, twice daily and by pilot and theodolite, twice daily.

Measurements of atmospheric ozone content are made as opportunity arises using a Dobson spectro-photometer.

Radiophysics :—Routine ionospheric vertical soundings are made as at Mawson.

"Whistlers" and "Dawn Chorus" are recorded at 30-minute intervals for systematic study.

Aurora :—Studies of auroral morphology are carried out as at Mawson. A 41 Mc/Sec radar has been installed to record the range of back scattering regions in auroras to the south of Macquarie Island.

Geomagnetism :—Observatory programme as for Mawson.

Seismology :—Equipment comprises two Wood-Anderson short-period horizontal seismographs and a Grenet short period vertical seismograph. These instruments are maintained in continuous operation.

Cosmic Rays :—Time variations in the meson component are recorded with a $60\text{ cm} \times 60\text{ cm} \times 60\text{ cm}$ geiger counter telescope, directed vertically.

There are at present 29 men at Mawson, 16 at Macquarie Island and 4 at Davis. They are relieved every year and it is the general policy of the Antarctic Division not to permit a man to spend two successive years at the same station. Scientists must bear their share of the burden of general camp duties and they are encouraged to take part in field journeys. The physicists work as a team and when one is away from the Station his duties are carried on by the others.

The high morale which has been consistently maintained by successive parties of scientists at these stations can be attributed to :—

- (a) the great amount of work with which they are faced during the year ;
- (b) the fact that they work as a team and are stimulated and broadened by scientific discussions with other members of the group ;
- (c) the provision of a good library of modern geophysical textbooks and journals ;
- (d) the opportunity for a break from station routine provided by occasional journeys into the field ;
- (e) the provision of separate huts for each discipline.

There is no lack of adventure for the geophysicists selected for work with the A.N.A.R.E., for they accompany field parties and gather geophysical data whenever opportunity offers. When landings on unknown coasts are made by men from the relief ship, magnetic and gravity readings are taken. By means of aircraft operating from Mawson, geophysicists are dropped at selected places with their equipment and left for several days to make observations before being picked up again and returned to base. By such means absolute magnetic measurements and gravity observations have been made at selected points along the whole of the coast of Australian Antarctic Territory west of Adélie Land and at various points inland in MacRobertson Land.

One of the most difficult observatories to maintain is the auroral observatory at Hurd Point which is run as a subsidiary to the main station at Macquarie Island. Situated at the extreme southern end of the Island and about 20 miles from the main station, it can be reached on land only by an arduous walk over the rough dissected plateau of the Island. Physicists take turns to make the trip, accompanied by non-scientific members of the party, and to man the observatory for periods varying from one to three weeks.

Stores and equipment for Hurd Point must be landed by sea, using rubber pontoons, on a dangerous surf-pounded beach. Such landings have provided some of the hardest work and the most rugged adventure in the records of the A.N.A.R.E., for the coast is exposed to the long swells of the Southern Ocean and calm conditions are extremely rare.

One antarctic project which constitutes a field expedition in its own right is that in which geophysicists are making measurements of the depth of ice on the Antarctic Continent. In the summer

of 1957-58 a seismic team with two tractor trains reached a point 408 miles inland from Mawson. They obtained ice depth measurements by seismic soundings every 20 miles along this traverse, interpolating gravity observations every five miles. Their deepest measurements, at an altitude of 9,000 feet, showed 6,300 feet of ice overlying the continental antarctic rock.

The responsibility for the scientific work of A.N.A.R.E. is divided between a number of organizations, for it is the policy of the Antarctic Division to farm out scientific projects to institutions which are equipped to do the work rather than itself to attempt to carry it out. Thus, the Bureau of Meteorology (Department of the Interior) directs and carries out the meteorological programme ; the Bureau of Mineral Resources, Geology and Geophysics (Department of National Development) accepts full responsibility for geology, geomagnetism, seismology, gravity and seismic ice-depth measurements ; the Ionospheric Prediction Service (Department of the Interior) maintains the ionospheric sounding equipment ; the Physics Department of the University of Tasmania jointly with A.N.A.R.E. is responsible for the cosmic ray work ; the Physics Department at Adelaide University is carrying out the radar meteor work on ionospheric winds ; the Physics Department of the University of Brisbane is supervising the "whistler" project. The Antarctic Division itself handles the auroral programme and its chief physicist, Dr. F. Jacka, is also responsible for the I.G.Y. programme of auroral observations throughout Australia. Fauna studies are directed by the C.S.I.R.O. Wild Life Section, while the assistance of the C.S.I.R.O. Division of Fisheries and Oceanography and of certain Departments of the University of Sydney has been sought for the programme in marine biology.

There are, of course, many difficulties inherent in carrying out scientific work in Antarctica. As a relief ship visits the stations only once each year, a fool-proof supply system is essential and considerable imagination (combined with a certain amount of ruthlessness) must be exercised in providing spare parts for equipment. Here experience is of great value, and a continuing expedition has in this respect great advantages over one which goes away for merely a one or two-year period. However, one still runs the risk of serious damage to equipment on the voyage or during unloading operations.

Electrical problems are many. Often insufficient provision for electric power is made when a station is first set up, and developments in sub-

sequest years force a re-organization of the electricity supply system. Poor earthing qualities of the terrain, combined with a large variety of electrical equipment and radio aerials, make interference problems acute. Radio reception is poor if the stations, like ours, are close to the auroral zone, and frequent radio blackouts interrupt the regular transmission of meteorological and other data back to Australia.

It is most important that any scientific projects which are started in Antarctica should have adequate sponsorship and backing. In general the men who go south are young and fairly inexperienced graduates; they need the advice and guidance of senior scientists at home who are enthusiastically interested in the projects. An adequate period must be allowed for the training of any expedition scientist before he departs for Antarctica and provision must be made for his retention to complete his analysis of results after his return.

The final stage of all expedition work is the publication of results, but only with considerable effort is it possible to publish reports within a reasonable time of an expedition's return. Publication by the A.N.A.R.E. is achieved by three main methods:

- (a) in scientific journals;
- (b) in A.N.A.R.E. Reports;
- (c) in A.N.A.R.E. Interim Reports.

A list of the geophysical reports and papers already published is appended.

It is only by continuous work over a long period of years that many geophysical problems in Antarctica can be solved. With ten full years of work behind it, the A.N.A.R.E. looks forward to the maintenance of its main stations at Mawson and Macquarie Island for a number of years to come.

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The Role of Practical Work in the Education of the Physicist*

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It is, perhaps, advisable to begin by emphasizing that we are concerned with the rôle of practical work in the education of the future physicist, and not with the place of physics as part of a liberal education, interesting and important though the latter subject may be. Our task, however, is wider than this limitation of the subject might imply. Who are the physicists? The university lecturer, facing his Honours physics class, has the answer before him—a number of young men, and women, to whom the subject appeals either as a discipline worth studying for its own sake, leading to a career in teaching and/or research, or as the basis for a career in applied physics in industry. Here I intend to concentrate on work at school level; and on the science teacher about to give the first lesson in science to an unstreamed class of eleven-year old children rests a grave responsibility. Is the physicist born, or is he made? Is the feeling for physics a gift or can it be cultivated? Is it true that your first class brain could be good at any subject? Whatever the answers to these questions may be we can be sure of one thing; at this stage in their education the children will be interested in science—eager to learn about it. It is our task to foster this interest in all our pupils, but above all to detect and develop any special aptitude for science shown by any of them—to see that any spark of genius is not frustrated, to show all of first class ability that the study of science is as exciting and as intellectually rewarding as that of other disciplines, and to realize to the full the potentialities of those who, while they may be incapable of leading in the scientific field, may make a valuable contribution, as technologists or technicians, to the nation in its struggle for survival in this scientific age. In the task of attracting the best brains in the country towards the study of science we must face the fact that we are competing with our colleagues who have specialized on the Arts side. In this competition we have one outstanding advantage. While their study of their specialist subject is largely retrospective ours is, or should be, only

partly so. Science is not merely something you learn about, it is something you do—a living human activity. While we may make use of artificial visual aids such as charts, films, film-strips and the like we do not have to rely on them. We can dispense with dogma and didacticism and bring our pupils into actual contact with the phenomena which are the subject of our study. We can give them first hand experience of the known and teach them to use it to explore the unknown. Science for them can be a reality and the pursuit of it a true voyage of discovery.

The pioneers of science teaching appear to have had no doubts as to the importance of a practical approach to the presentation of their subject. It is my contention that a great deal of present-day science teaching is ineffective, and the interest of many clever pupils in the subject is killed, because practical work in science has been relegated to a subsidiary position, in favour of a study of the written word, the memorizing of bookwork and the reproduction of answers to stereotyped examination questions.

Physics, for the purpose of writing textbooks, setting out a syllabus, or teaching it, is traditionally divided into branches—mechanics and properties of matter, heat, light, sound, electricity and magnetism. It appears to be a fairly widespread practice in schools to treat practical physics as if it were yet another, separate, distinct branch of the subject—something for which the pupils must be prepared in addition to those aspects of the subject which are tested in written theory papers. I know that I am not alone in thinking that if the formal practical examination were dropped there would be not a few schools in which the amount of practical work done would be drastically reduced, even below its present inadequate level. Practical work and theoretical study should be closely correlated. Theoretical development should be based on practical experience and should, in turn, lead to a further appeal to experiment. To show how the teaching of physics could be infused with, and used to develop, a true

*Based on a talk given to the Easter Conference of the Education Group, and South-Western Branch, at Bristol, April 10, 1958

scientific attitude it is helpful to analyse the practical work according to the scheme shown below, with a warning that, while it may provide a convenient framework for discussion, it is not intended to imply that this side of the work falls into watertight compartments.

Practical Physics	Demonstration	1. Stimulating interest and wonder.
		2. Enlightenment.
		3. Experiment.
	Laboratory work	4. Technique.
		5. Experience.
		6. Experiment.

The results of research on the relative effectiveness of demonstration by the teacher and laboratory work by the pupils appear to be inconclusive. I certainly cannot agree with those who would rely entirely on the former, depriving the pupils of all direct experience of physical phenomena—of any opportunity to get the “feel” of things or to show initiative in planning procedure and constructing apparatus. On the other hand, to think that the ground which the pupils can cover in their own laboratory work will provide an adequate basis for a varied, wide-ranging and stimulating study of elementary physics appears to me to be unrealistic.

Chief criticism of practical work on the laboratory side must be directed less at the quantity than at the nature of the work done. When a pupil enters the physics laboratory he takes a step backwards, into the past. I do not mean simply that he finds himself in the tangent galvanometer era, but that the work he does is mere repetition—repetition of stock experiments, with standard apparatus, following cookery-book instructions from a text book of practical physics or laboratory manuscripts, making the specified measurements, substituting in a given formula, and finally presenting for approval an “answer” which gives both pupil and teacher an entirely false impression of the progress the former is making in a real appreciation of physical principles. He is set, for example, to verify Boyle’s Law, producing results which often tend to shake confidence in that generalization rather than to confirm it. The instructions may, of course, be so worded that the teacher deceives the pupil (and himself!) into thinking that the law is being not merely verified but actually discovered. In this case, when it is later revealed that this law was discovered by Boyle in 1662 the pupil may be forgiven if satisfaction at emulating the achievement of this famous scientist is tempered by the thought that he himself appears to have progressed backwards.

Now, I am not going to be so provocative as to suggest that such work is entirely valueless. It clearly provides opportunities for acquiring technique in manipulation (item 4 in the table) and for getting the “feel” of things (item 5—experience). But these could equally well be acquired if the pupil were trying to solve a real problem (item 6). It would be more effective, I think, to devise a really striking demonstration which would suggest the plausibility of the law (item 2) and to let the pupil read Boyle’s own entertaining account of the way in which the law was discovered. Then we proceed to test his grasp of the principle by setting him a practical problem on it, such as using the law to check the accuracy of a motor tyre pressure gauge, or investigating to what extent sulphur dioxide obeys the law, or, in the case of a very advanced student, using the law to find the density of the solid in a porous or powdered material. By asking him to apply principles to the solution of a real problem and to use initiative in the devising of suitable apparatus and procedure, we encourage the pupil to feel that he is not merely learning about science but *doing* science.

This attitude of problem solving should be adopted from the earliest stages in the school science course. At first, of course, a great deal of direction will be required, and the problem may be merely a small addition to a standard laboratory exercise. As the pupil progresses the amount of guidance is steadily withdrawn until, in the later stages of the sixth form course, he can profitably devote several laboratory periods to one piece of investigation. It is pleasing to note that some examining bodies set special practical papers at scholarship level which encourage such work. Practical examinations at all levels which test something beyond mere proficiency in repeating stock “experiments” would have a vitalizing effect on school laboratories.

Another stultifying influence would be removed if physics teachers could escape from their obsession with the quantitative work which appears to be the sole aim in all but the most elementary laboratory exercises. In the long run it is undoubtedly true that “until you can measure what you are talking about and express it in numbers your knowledge of it is incomplete and unsatisfactory,” but one result of Lord Kelvin’s famous dictum is that pupils spend their time measuring and expressing in numbers things of whose physical significance they are profoundly ignorant. In many experiments the *physics* lies not so much in the making of the measurements and calculation of results as in the preliminary choice of

suitable values for components, devising of procedure which will safeguard delicate apparatus or reduce sources of error, and achieving a set-up which will work smoothly to avoid the necessity for a major re-adjustment when the process of taking readings is under way. Here nothing can be so effective as preliminary discussion between teacher and class, or between teacher and individuals as the experiment proceeds, but skilful wording of laboratory instruction sheets can go a long way towards developing the attitude of a critical experimenter. It is a good practice to conclude printed instructions with some searching questions which test understanding of physical principles involved in the procedure or calculations, and to insist that answers to these questions shall appear in the written account of the experiment—in fact it is far more profitable for the pupil to devote to this much of the time and space now used in copying out the printed instructions under the heading of "Method."

Thirdly, some misplaced emphasis on refinements in technique calls for criticism. A potentiometer, or a Wheatstone's Bridge, for example, is a means to an end, not an end in itself. Their use by "O" level pupils to compare the e.m.f.s of cells or to measure the resistivity of eureka wire become mere exercises in which the initial aim of the experiment is lost in the complexity of the apparatus. In a school elementary laboratory results of equal reliability could be obtained more quickly with ammeter and voltmeter. In the time available, and using the direct reading instruments, the class could investigate the effect of temperature on the resistance of a filament lamp, compare the resistivities of copper, and nickel and their alloys, or study the polarization and recovery of a dry cell. On the other hand, a sixth form specialist *can* understand the theory of the potentiometer or bridge circuits, would appreciate the accuracy of standardizing measurements in terms of standard resistance and standard cell, and could use them to check the accuracy of ammeters and voltmeters used, e.g., in a measurement of specific heat by electrical heating. He would appreciate the value of the bridge in measuring small changes in resistance and could use it to find the working temperature of, e.g., the coils of a transformer. In optics, again, focusing the image of a luminous object on to a screen gives a much more direct insight into the physics of the optical device than do pin and parallax methods, and since the latter are very time-consuming use of the former will allow far more experience to be gained in the time available. Examining bodies who insist on pin and parallax methods, on the

demonstrably false ground that they lead to greater accuracy, are doing a great disservice to the teaching of elementary optics.

The three items associated with Demonstration in my table must be dismissed with a brevity out of proportion to their importance. If a larger part of the available laboratory time is to be used to foster an enquiring spirit by tackling problems (i.e., doing "experiments" in the real sense of the term) it follows that much of the material which now forms the basis of laboratory work must be handled in the classroom by way of demonstration. Now, a demonstration may be used for the simple, naive purpose of arousing interest and creating wonder, e.g., crystal growth shown with a micro-projector, sound waves made visible by the schlieren technique, a Wilson cloud chamber, discharge tube phenomena. A thorough discussion of the many physical principles involved in such examples may also be used to give an air of freshness to the task of revision when a topic is completed. Again, a demonstration may be devised to assist us in putting over some difficult concept, e.g. a working model of the kinetic theory to illustrate ideas concerning the existence of three states of matter and change of state, wave machines to clarify the mechanism of wave motion and ripple tanks to illustrate by analogy the propagation of sound and light, a double-beam oscillograph to display the primary current and secondary e.m.f. in a spark coil and the effect of the condenser.

In the transfer of material from laboratory to demonstration bench, however, lies the possibility of an even greater gain in effectiveness. A good teacher is not content to use demonstration merely to give variety to a lesson or to counteract boredom (item 1). Nor does he limit its use to that of a mere visual aid (item 2). The whole exposition of a topic may be built up on a series of well chosen demonstrations. Moreover, by the skilful use of question and answer, with class participation in the performance of the experiments, he may actually achieve an atmosphere of investigation (item 3) in a way which is almost impossible when a practical session in the laboratory has to be preceded by the issuing of standardized verbal or printed instructions. Here much depends on the histrionic ability of the teacher. To take a simple example—having dealt with the magnetization of a bar of iron inside a coil carrying direct current one might pretend to be suddenly struck with the idea of trying alternating current. The class is invited to predict the outcome, their reasoning is discussed (e.g., in the light of the "molecular" theory of magnetism) and finally the

prediction is tested. The results, incidentally, may lead to a more thorough quantitative investigation in the laboratory. Any such suggestion which is known (to the teacher) to be fruitful should be taken up, if necessary at the expense of scrapping some part of a prepared lesson. And, of course, a demonstration which fails provides an opportunity for investigation which must not be ignored. Problems usually set as written tests can be more effective if presented practically, as the following example will show. The deflection of a galvanometer connected to a coil is observed when a bar magnet is introduced, North pole first, into the coil and then withdrawn. The class is reminded of the laws of electromagnetic induction which explain the observed effects. The magnet is then replaced and the class asked to predict the direction of the galvanometer deflection if the magnet is withdrawn through the other end of the coil. Individuals are asked to support their prediction by revealing their reasoning, and when argument has died down the final verdict is tested by performing the experiment. Such work soon leads to the abandoning of guesswork and to increased confidence in reliance on application of principles.

When discussion is invited on the attitude towards science teaching outlined above it is not unusual for some speakers to confess publicly their shame that their own practice falls far short of what they admit to be desirable. Others insist that the approach is impracticable for a variety of reasons—shortage of trained laboratory assistants, insufficient laboratory and lecture room accommodation,

inadequate allowance for purchase of apparatus and materials. But these are obstacles to be overcome. They are not valid arguments in favour of a deadening approach to a living subject. When a master is burdened with routine maintenance, when the correcting of pupils' written work is a drudgery and environment depressing it is all too easy to adopt a static attitude towards science teaching, but some manage to avoid it and give one at least a glimpse of what they could achieve if the restrictions were entirely removed. Yet, at the other end of the scale, one finds schools where the provision for science teaching is positively lavish but the whole effort seems to be directed towards the lowly aim of "defeating the examiner." "Take care of the physics and the examination will take care of itself" may be a counsel of perfection, but it puts the emphasis in the right place. The perverted, uninspired, debased attitude towards the study of science which has been criticized in this article is, I suspect, largely the result of too much preoccupation with the examination syllabus and the written answer to the examination question. If the true aim of science teaching is to be attained we must cease to pay mere lip-service to the practical side of the subject. Practical and theoretical studies must be correlated—integrated. Our study of science should be grounded in experience and should lead to a widening of experience. It should, in other words, be something which will justify the title of "Education in Physics."

Reviews of Books

QUANTUM MECHANICS (NON-RELATIVISTIC THEORY)

By **L. D. Landau and E. M. Lifshitz**

London: Pergamon Press. Pp. xii + 515. Price 80s.

This book has been awaited for some time and with considerable excitement by English speaking physicists. Their expectations had been raised by the same authors' excellent *Classical Theory of Fields* and by the knowledge that in Moscow there was in preparation a complete course of Theoretical Physics, monumental even by the standards of Planck and Sommerfeld. These expectations have been more than fulfilled.

The volume divides easily into two parts. The first nine chapters are concerned with the funda-

mentals of non-relativistic quantum mechanics. The list of subjects is orthodox, the treatment is not. To give an example, quantum mechanics is introduced through the experimental fact of electron diffraction. Although this is a reversal of the historical development the authors very wisely refuse to follow the latter, and from the logical point of view it is much more sensible to start wave mechanics with G.P. than with J.J. Electron diffraction leads naturally to the idea of a wave function. The contact with classical mechanics is made, by means of Hamilton's principle and two pages later one arrives, breathless but triumphant, at $i\hbar \delta\Psi/\delta t = H\Psi$. The operator expressions for momentum, angular momentum and kinetic energy are then intro-

duced through the principle of Galilean relativity. The result is that the principles of quantum mechanics grow naturally out of experiment (Galilean relativity is an experimental fact!) and do not have to be postulated as a dogma that has a faint air of plausibility.

The second part deals with applications which are chosen almost entirely from atomic and molecular physics. This is presumably a consequence of the fact that the book was essentially complete eleven years ago, but it does mean that problems important in nuclear physics receive little or no mention. A more serious criticism is that the chapters on collision theory might have been written 20-25 years ago. The use of the variational principle in scattering is not even hinted at. On the other hand, the pre-occupation with molecular physics results in a very clear chapter on group theory.

Treatment and presentation clearly owe a great deal to a most lively lecturing technique and it is a pleasure to find that the sort of illuminating remark that makes a lecture come alive is still there in asides and footnotes. Further clarification is provided by countless worked examples. The fact that two of Russia's leading physicists, still only in their forties, have undertaken the enormous task of assembling their lectures on theoretical physics into a nine volume work is an indication of the importance with which teaching is regarded in Russia and the esteem in which it is held.

The book is pleasantly produced, well printed and remarkably free from misprints. Students of dustjacket literature will enjoy a comparison between the blurb and the preface.

L. R. B. ELTON.

DICTIONARY OF PHYSICS

By H. J. Gray

London: Longmans, Green and Co. Ltd. Pp. x + 544. Price 84s.

Aldous Huxley once said that the best reading on holiday was to be found in a volume of the *Encyclopaedia Britannica* chosen at random; a dictionary provides something of the same inconsequent fascination, but unless it is of monumental size suffers from the defect that it dispenses its information in exasperatingly small doses. This *Dictionary of Physics* succeeds in satisfying the inquirer because many articles are long enough to give a bird's eye view of the subject, and references to other authorities are frequent and to the point. Browsing within its covers is insidiously easy, cross references leading one from entry to entry.

Generally speaking it is true to say that modern developments and discoveries are well represented, especially in the field of nuclear physics. There are, however, gaps, some of them surprising. For instance, on looking up *Coriolis*, one is directed to an entry under *Force*, where *Coriolis* forces are mentioned as being involved in problems of projectiles shot from the surface of the rotating earth; artificial satellites are not listed, so naturally *sputniks* are not to be found, but under *rockets* there is no entry save a reference to *astronautics* where, at last, the reader may learn that the Russians launched earth satellites in 1957.

An even more surprising example is the lack of all reference to radio-telescopes, steerable or fixed, and though four lines are devoted to *radio-astronomy* the only reference is to an article in *Nature* six years old. The Editor asks for suggestions for future editions and will doubtless have a ready response. His task is unenviable but he has achieved much and many readers will be grateful to him and his contributors. His inclusion of numerous biographical notes will gladden the hearts of those older physicists to whom ignorance of the great names of science is a distressing characteristic of the younger generation in whose eyes history is often of little consequence.

A. M. TAYLOR.

FILM STRIPS FOR CLOUD STUDY

London: Produced by Diana Wyllie Ltd. Price 37s. 6d. each (double frame); 27s. 6d. each (single frame).

These two 35mm colour filmstrips are intended to illustrate the physical processes of cloud formation. Filmstrip A consists of 24 frames showing photographs of haze, convection clouds, and ice clouds. Filmstrip B deals with layer, wave, and billow clouds; it consists of 22 cloud photographs and three diagrams illustrating the formation of wave clouds by mountains.

The photographs are well selected, but the quality of reproduction of many of them is disappointing, and not up to the standard one expects from good colour transparencies. There is a lack of crisp definition and the colour balance is often faulty—the bright green cumulonimbus sky shown on Frame 6 of Filmstrip A would surely presage something much more terrible than a thunderstorm!

The filmstrips are accompanied by a 20-page booklet of notes by F. H. Ludlam and R. S. Scorer, the authors of a recent book, *Cloud Study* (reviewed in the *Bulletin*, Vol. 9, No. 2, p. 43).

These notes are excellent and enable a non-specialist on the subject to use the filmstrips as the basis for an instructive lecture which could be appreciated by almost anyone—it would not be so easy, however, to answer questions which might be raised after the lecture!

J. S. FORREST.

MATHEMATICAL THEORY OF COMPRESSIBLE FLUID FLOW

By R. Von Mises. Completed by H. Geiringer and G. S. S. Ludford

New York: Academic Press Inc. Pp. 514. Price \$15-00

The book under review is entirely devoted to an account of the exact theories of fluid flow. It was begun by R. Von Mises who intended it to be a comprehensive work on compressible flow, but when he died in 1953 only the first three chapters had been written. H. Geiringer and G. S. S. Ludford edited these chapters, added two more and an appendix of notes to augment the text, and the book was published in the present form.

In a book which is concerned with the more highly mathematical parts of the subject, it is reasonable to expect a careful exposition of the basic ideas and equations. This is for the most part achieved in Chapter I where the equations of motion are derived from a statement of Newton's laws and where Mach lines the propagation of small disturbances and the essential differences between subsonic and supersonic flow, are carefully explained. The thermodynamics is not so well presented. The entropy is defined on page 8 (for a polytropic gas only) in terms of the pressure and density. From this definition and the energy equation, the second law of thermodynamics then appears as a consequence (page 30) which gives quite a false impression of its significance. It is also usual to invoke the second law of thermodynamics to explain why a shock wave must be compressive, as opposed to the argument in Chapter III which generalizes a particular example. Furthermore this reviewer could not understand the reluctance on page 49 to define the square of the velocity of sound as the derivative of the pressure with respect to the density at constant entropy.

Otherwise the material is well presented and the reader is led through the complexities of the hodograph transformation, a detailed account of the theory of characteristics, shock waves, simple waves and a collection of specific problems in one dimensional flow and plane steady potential

flow. The peculiar difficulties of transonic flow are well explained in the final chapter of the book.

Perhaps the chief criticism is that one gets the impression from reading the book that fluid mechanics is a branch of mathematics, and only remotely connected with physical reality. No doubt this is due in large measure to the fact that the mathematics is not easy and hence particular attention must be paid to it. Yet mention could have been made, for example, of the compressibility correction factor used by aeronautical engineers which is a direct consequence of the Karman-Tsien hodograph method.

The book can nevertheless be recommended to all those who wish to see what can be done with the equations of fluid dynamics without having recourse to simplifying approximations.

W. CHESTER.

DIFFERENTIAL EQUATIONS

By F. R. Moulton

Pp. viii + 395. Price \$2-00

MATHEMATICAL TABLES

By H. B. Dwight

Pp. 217. Price \$1-75

New York: Dover Publications Inc.

This new edition of differential equations is dedicated to the author who died in 1952 at the age of eighty. The book, first published in 1930, is restricted to the solution of systems of ordinary differential equations; these are discussed in great detail and with many interesting applications, revealing as it is to be expected the author's interests in celestial mechanics. The standard of rigour throughout is high. "It is essential for progress in interpreting the world about us that the methods of applied mathematics should be improved as much as the experimental results have been, for the remarkable recent discoveries in every domain of physical science have given rise to numerous intricate theories whose consistency with one another and with observed phenomena can be assured only by the use of sound logical tools."

There are separate chapters devoted to practical problems, for example, elliptic motion under a central force, the deviations of falling bodies and the damped gyroscope. There is an interesting account of the method of successive integrations (approximations), followed by a chapter on numerical solutions, and there is a full discussion of linear differential equations with constant coefficients and with periodic coefficients.

Dwight's mathematical tables first appeared in 1941. They include not only the usual logarithmic, trigonometric and exponential tables, but values of complete elliptic integrals of the first and second kind, binomial coefficients, factorials, surface zonal harmonics, the error function, Bessel functions and many others.

J. TOPPING.

PHYSICS. VOLUME II, ELECTRICITY AND MAGNETISM

By L. S. Powell

*London : Sir Isaac Pitman & Sons Ltd. Pp. xv + 543.
Price 30s.*

Ordinary and Higher National Certificates in applied physics are being awarded year by year in increasing numbers at many colleges of technology throughout the country. The standard of the Higher National Certificate approximates to that of an Ordinary (pass) degree in physics and successful candidates, many of whom have had to work in difficult circumstances, deserve considerable credit. The provision of suitable textbooks for the Ordinary and Higher courses, and covering all branches of physics, is clearly vital and the present work is the second of a series of three volumes covering the syllabus of the three years' course for the Ordinary National Certificate.

The treatment is comprehensive, and naturally great stress is laid on worked examples, of which there is a profusion, and on simple explanatory diagrams. The style is concise and very readable, the production of the book is good and the price reasonable.

J. D. CRAGGS.

A COMPENDIUM OF MATHEMATICS AND PHYSICS

By Dorothy S. Meyler and O. G. Sutton

*London : English Universities Press Ltd. Pp. x + 384.
Price 25s.*

This is described as "a unique compilation of the most frequently used formulae in mathe-

matics, physics and elementary statistics up to General Honours standard." There are two parts to the book : the first part, by Miss Meyler, is devoted to pure mathematics, whilst the second part, by Sir Graham Sutton, traverses most of the branches of physics in the space of little more than a quarter of the whole book. It is not intended as a mere collection of formulae, but "explanations are given as far as space permits." These limitations of space must have been a major problem for both authors, for the book must be judged partly on its comprehensiveness but also on the clarity and completeness of the information selected. Inevitably the book is uneven, and more care would seem to have been bestowed on the first part. This includes useful chapters on matrices and determinants, sets and finite groups, homogeneous co-ordinates, differential geometry as well as fairly complete surveys of plane trigonometry, spherical trigonometry, two- and three-dimensional analytical geometry, differentiation and integration, and differential equations. There is a short chapter on vectors which would have been more valuable if given earlier in the book, and the techniques used appropriately elsewhere. It is, nevertheless, an impressive summary of certain branches of pure mathematics, with no mention of all those important practical topics usually grouped under the term "numerical analysis."

Applied mathematics is included in the physics part of the book which opens with mechanics of particles and rigid bodies, followed by short chapters on the traditional sections of the subject and a final one, as would be expected from the author, on meteorology. In electricity formulae are quoted in both the classical and rationalized m.k.s. system of units.

It is difficult to judge how useful this book will be for the two classes of readers specially mentioned, namely, research workers and "undergraduates or technical students." The latter may find it helpful for general revision ; the former whilst finding here some useful fundamental formulae will more often have to go elsewhere.

J. TOPPING.

Forthcoming Institute Meetings

Date	Place	Speaker	Title	Time	Branch or Group
Oct. 15	Newcastle upon Tyne King's College	Prof. S. Tolansky, F.Inst.P., F.R.S. (Royal Holloway College, Egham)	Optical studies on the microstructures of diamonds	5.30 p.m.	North Eastern
Oct. 15	Sheffield The University	Prof. R. Pepinsky, (Pennsylvania State University)	The revision of Groth's <i>Chemische Kristallographie</i>	5.30 p.m.	X-ray Analysis Jointly with the Sheffield Crystallographic Colloquium
Yorkshire Branch members will be particularly welcome to attend this meeting.					
Oct. 17	Cardiff University College	Prof. E. R. Andrew, F.Inst.P., F.R.S.E. (University College of North Wales, Bangor)	Nuclear magnetic resonance	5.15 p.m.	South Wales
Oct. 17	Bristol The University	Dr. R. A. Smith (Royal Radar Establishment, Malvern)	The use of infra-red spectroscopy in the study of semi-conductors	7.00 p.m.	South Western
Oct. 17	London The Institute's House	<i>Proposers:</i> Mr. W. G. Cook (Rolls Royce Ltd., Derby) and Mr. B. D. Burns, A.Inst.P. (Armament Research and Development Establishment, Fort Halstead) <i>Opposers:</i> Dr. E. G. Stanford, F.Inst.P. (Aluminium Laboratories, Ltd., Banbury) and Mr. N. Clarke, F.Inst.P. (Deputy Secretary, The Institute of Physics)	Group Annual General meeting followed by debate on the motion:— That this House considers that the Non-Destructive Testing Group serves no useful purpose	6.00 p.m.	Non-Destructive Testing
Oct. 20	Manchester The University	Mr. J. Maddox (Scientific Correspondent, Manchester Guardian)	Writing about science	6.45 p.m.	Manchester and District
Oct. 20	Edinburgh The University	Dr. P. S. Farago (University of Edinburgh)	The spinning electron		Scottish
Oct. 21	Glasgow The University	Dr. P. S. Farago (University of Edinburgh)	The spinning electron		Scottish
Oct. 22	Aberdeen The University	Dr. P. S. Farago (University of Edinburgh)	The spinning electron		Scottish
Oct. 23	Birmingham Exchange and Engineering Centre	Dr. A. Gibson (Controlled Thermo-nuclear Reactor Division, A.E.R.E., Harwell)	Thermonuclear power	7.00 p.m.	Midland
Oct. 29	Leeds The University	Dr. L. Mackinnon (University of Leeds)	Ultrasonics—super-conductivity—liquid helium	3.00 p.m.	Yorkshire

Date	Place	Speaker	Title	Time	Branch or Group
Oct. 31	London The Institute's House		At Home. Attendance by ticket only	7.30 p.m. to 11.00 p.m.	London and Home Counties
Nov. 6	Bangor University College	Prof. J. F. Allen, F.R.S. (University of St. Andrews)	Liquid helium	5.45 p.m.	Liverpool and North Wales
Nov. 10	London The Institute's House	Dr. N. A. de Bruyne, F.Inst.P. (Aero Research Limited, Duxford)	Physics of adhesives	6.00 p.m.	London and Home Counties
Nov. 10	Edinburgh The University	Prof. E. G. Cullwick (Queen's College, Dundee)	The riddle of relativity	7.15 p.m.	Scottish
Nov. 11	Glasgow The University	Prof. E. G. Cullwick (Queen's College, Dundee)	The riddle of relativity	7.15 p.m.	Scottish
Nov. 12	Durham Science Laboratories	Dr. L. Essen (National Physical Laboratory, Teddington)	Astronomical and atomic time	5.00 p.m.	North Eastern
Nov. 13	Liverpool The University	Four speakers from industry	Discussion on The physicist in industry	4.00 p.m.	Liverpool and North Wales

News of Members

FELLOWS

- W. J. G. Benyon is now Professor of Physics at the University College of Wales, Aberystwyth.
- D. H. Black has been appointed Director of the Armament Research and Development Establishment at Fort Halstead, Kent.
- W. Cochran was recently awarded a bursary under the Royal Society and Nuffield Foundation Commonwealth Bursaries Scheme in order to allow him to spend a year in Canada to study neutron diffraction techniques.
- Sir John Cockcroft was awarded the 1958 Niels Bohr Medal for special contributions towards peaceful uses of atomic energy.
- D. T. E. Dassanayake recently retired from the post of Director of Colombo Observatory, Ceylon.
- J. J. Dowling has retired from the Professorship of Technical Physics at University College, Dublin.
- H. W. Emerton has recently joined Albert E. Reed and Co. Ltd., in the Pulp and Paper Research and Development Division at Aylesford, Kent.
- D. Gabor is now Professor of Applied Electron Physics at Imperial College of Science and Technology, London.

- E. George was recently appointed Principal of Wellingborough Technical College, Northants.
- H. A. Hughes has joined the staff of the Windscale Works of the United Kingdom Atomic Energy Authority as Chief Technical Officer.
- D. I. Lawson is now Director of Fire Research at the Joint Fire Research Organization of the D.S.I.R., Boreham Wood, Herts.
- L. A. Micco is working in the Scientific Instruments Division of Beckman Instruments Inc., Fullerton, California.
- H. S. Peiser has been appointed Chief of the Mass and Scale Section of the Mechanical Division of the National Bureau of Standards, Washington, U.S.A.
- G. D. Robinson is a Deputy Director of the Meteorological Office, London.
- M. Stephenson is now head of the Oil Production Development Division of Shell (Petroleum) at The Hague, Holland.
- A. Whitaker was recently made an Honorary Fellow of the Royal College of Art.

ASSOCIATES

- M. E. Baird is working in the Coal Research Establishment of the National Coal Board, Stoke Orchard, Gloucestershire.

- C. J. Ball has joined the staff of the Physics Department of Makerere College, Kampala, Uganda.
- R. A. Bones has been appointed Deputy Director of Research of the Federal Institute of Industrial Research, Lagos, Nigeria.
- W. S. Brown has taken up an appointment at the Matthew Boulton Technical College, Birmingham as Lecturer in Physics.
- H. L. Carson is now with the Central Electricity Research Laboratories at Leatherhead.
- D. A. Davies is employed in the Health and Safety Department of the U.K. Atomic Energy Authority at Capenhurst.
- L. W. Davies has been awarded a Dominion Civil Service Fellowship by the Commonwealth Fund of New York and will be engaged on research in semiconductor physics at the Bell Telephone Laboratories, New Jersey.
- J. K. Donoghue has taken up a post with the U.K. Atomic Energy Authority at Salwich in the Health and Safety Section.
- A. Dudley is now on the staff of Southport Technical College as an Assistant Lecturer.
- N. J. Dunning has taken a post with the U.K. Atomic Energy Authority at the Industrial Group Headquarters at Risley, Lancs.
- E. Dyson is now in the Department of Textile Industries of Bradford Institute of Technology.
- M. G. East has recently joined the staff of the Bramcote Hills Grammar School, Nottingham, as Head of the Physics Department.
- E. M. Healey is working in the Physics Department of the Coal Research Establishment at Stoke Orchard, Gloucestershire.
- A. H. Higgs has joined the staff of Lakehead College of Arts, Science and Technology, Ontario, Canada.
- D. H. Houseman will shortly take up a post as Head of the Metallurgy Department at Sir John Cass College, London.
- T. K. Jones is working in the Research Department of the English Steel Corporation at Sheffield.
- E. Kendrick is employed by Esso Research Ltd., Abingdon, Berks.
- G. F. G. Knipe is Professional Officer at the Union Observatory, Johannesburg.
- L. Krause has joined the staff of the Department of Physics at the Assumption University of Windsor, Ontario, Canada.
- D. H. Le Croissette has been appointed Associate Professor of Electrical Engineering at the Drexel Institute of Technology, Philadelphia, U.S.A.
- C. G. McCue is taking up a post as Lecturer in Physics at the Royal Military College at Duntroon, Australia.
- M. J. Morant is now Henley Research Fellow at Queen Mary College, London.
- R. E. Newnham has joined the staff of the Physics Department of Massachusetts Institute of Technology, U.S.A.
- R. B. Pepper is in the Health Physics Section of the Nuclear Power Branch of the Central Electricity Generating Board, London.
- E. R. Pike is on the staff of the Physics Department of Massachusetts Institute of Technology, U.S.A.
- A. C. Reid is Head of the Physics Department at Grimsby Wintringham Boys' Grammar School.
- G. R. Southam is now Headmaster of Ashville College, Harrogate, Yorks.
- J. G. Thomason has joined Imperial Chemical Industries Ltd., at their Central Instrument Laboratory at Reading.
- E. G. Toothill has joined the staff of the Physics Department of Ryerson Institute of Technology, Ontario, Canada.
- A. Westerman has been appointed Research Manager of George Bray and Co. Ltd., Leeds.
- W. Weinstein will in future be known as W. T. Welford.

GRADUATES

- C. Charlton is employed as an engineer with Canadair Ltd., Montreal.
- B. A. Goddard is with the Sheffield National Centre for Radiotherapy as Assistant Physicist.
- R. M. Hill is a Research Officer in the Division of Metrology of the C.S.I.R.O., Sydney.
- D. W. G. Hooper has been appointed Lecturer in Mathematics and Physics at The College, Chester.
- K. J. Hughes has taken up an appointment as Physicist at Colodend Ltd., Bristol.
- P. J. Heywood has joined the staff of De Havilland Propellers Ltd., as a Senior Quality Engineer.
- C. Lloyd has taken up an appointment at the D.S.I.R. Building Research Station, Garston, Herts.
- V. W. Maslem is in the Chemical Physics Section of the Division of Industrial Chemistry of the C.S.I.R.O., Melbourne, Australia.
- J. Merchant is employed as a Defence Service Scientific Officer by the Defence Research Board at the Canadian Armament Defence Research Establishment, Quebec.
- D. E. Millington is with Joseph Lucas (Electrical) Ltd., Birmingham, as an Assistant Research Officer.

- A. S. Morrison is with the General Electric Co. Ltd., at Erith, Kent.
- S. A. F. Murrell is at the University of Sheffield in the Mining Department.
- C. O'Hara has been appointed a Research Physicist at the Thermal Syndicate Ltd., Wallsend, Northumberland.
- F. Paton is in the Physics Department of the University College of the West Indies, Jamaica.
- J. S. Sergeant is at the Methodist Mission, Gambia, West Africa.
- T. C. Sinclair has taken a post in the Atomic Power Division of the English Electric Co. Ltd., Whetstone, Leicester.

L. Stone is Senior Physics Master at Heckmond-wike Grammar School, Yorks.

W. G. Townsend has joined the staff of the University College of Swansea as a Lecturer in Electrical Engineering.

R. H. de Vere has taken up an appointment with the National Coal Board at their Central Research Establishment at Stoke Orchard, Gloucestershire.

P. G. Williams has been appointed Head of the Semiconductor Technical Department at the Mullard Radio Valve Co. Ltd., at Mitcham, Surrey.

The Register

ELECTIONS TO MEMBERSHIP

THE FOLLOWING ELECTIONS WERE MADE BY THE BOARD ON JULY 1, 1958

An asterisk () indicates transfer from another grade*

FELLOWS

- Boorman, Colin, B.Sc., Principal Scientific Officer, U.K. Atomic Energy Authority, Capenhurst.
- Croft, Antony Julian, B.A., D.Phil., Administrator, Clarendon Laboratory, Oxford.
- *Dryden, John Stuart, M.Sc., Ph.D., Lecturer, New South Wales University of Technology, Australia.
- *Farnell, Geoffrey Carlton, B.Sc., Ph.D., Senior Staff, Kodak Ltd., Harrow, Wealdstone, Middx.
- *Hogarth, Cyril Alfred, B.Sc., Ph.D., Head of Physics Department, Brunel College of Technology, Acton, Middx.
- *Hutchinson, Thomas Sherret, B.Sc., Ph.D., Professor and Head of Physics Department, Royal Military College, Kingston, Canada.
- Parsons, Ralph Whaddon, B.E., D.Phil., Professor of Physics, University of Hong Kong.

ASSOCIATES

- Alcock, Bede John, B.Sc., Ph.D., Chief Scientist, Denis Ferranti Ltd., Bangor, Caerns.
- Andrews, Edgar Harold, B.Sc., Physicist, The British Rubber Producers' Research Association, Welwyn Garden City, Herts.
- Ausburn, Kenneth John, M.Sc., Lecturer, New South Wales University of Technology, Australia.

Chackraburttty, Debangshu Mohan, M.Sc., Junior Research Officer, Atomic Energy Establishment, Bombay, India.

Clark, William Charles, B.Sc., Ph.D., Research Physicist, Laporte Titanium Ltd., Luton, Beds.

East, Michael George, M.A., Assistant Master, The Grammar School, Bristol.

Ellis, Geoffrey Frank, B.Sc., Senior Science and Physics Master, Sir John Leman School, Beccles, Suffolk.

*Evans, David Walter, B.Sc., Senior Engineer, E. K. Cole, Ltd., Malmesbury, Wilts.

Garden, Robert Andrew, B.Sc., Assistant Master, St. Lawrence College, Ramsgate, Kent.

*Hall, Ivan Harold, B.Sc., Technical Officer, Imperial Chemical Industries Ltd., Metals Division, Witton, Birmingham.

*Hall, Raymond Frederick, B.Sc., Ph.D., Senior Research Physicist, Mullard Research Laboratories, Surrey.

Hall, Raymond Watson, B.Sc., Assistant Lecturer, The Marine and Technical College, South Shields, Durham.

*Hendry, Innes Craig, B.Sc., Senior Scientific Officer, U.K. Atomic Energy Authority, Dounreay, Scotland.

Hill, Michael John, M.Sc., Senior Physicist, Clatterbridge Hospital, Bebington, Cheshire.

- Hodgett, Edward John Ferriss, B.Sc., Senior Technical Assistant, Turner Bros. Asbestos Co. Ltd., Rochdale, Lancs.
- Hornby, Harold Alastair, M.A., Senior Physics Master, Portsmouth Grammar School, Portsmouth, Hants.
- *Humphreys, David Arthur, B.A., Lecturer, North Staffordshire Technical College, Stoke-on-Trent, Staffs.
- Jenkins, Alwyn Edmund, B.Sc., Principal Scientific Officer, U.K. Atomic Energy Authority, Dounreay, Scotland.
- Linton, Geoffrey E., B.Sc., Assistant Lecturer, Medway College of Technology, Kent.
- *Kuffel, Edmund, M.Sc., Research Physicist, Metropolitan Vickers Electrical Co. Ltd., Trafford Park, Manchester.
- *Leach, Rodney, B.Sc., Ph.D., Physicist, Nuclear Power Plant Co. Ltd., Knutsford, Cheshire.
- *Loveless, Frederick Charles, Physicist, Twentieth Century Electronics Ltd., New Addington, Surrey.
- McKee, James Stanley Colton, B.Sc., Ph.D., Lecturer, University of Birmingham.
- Major, Ronald C., B.Sc., Research Department, S. Smith & Sons (England) Ltd., London.
- Martin, John W., M.Sc., Scientific Officer, Armament Research Establishment, Ministry of Supply, London.
- Morrison Trevor Walter, B.Sc., Geophysicist, British Petroleum Co. Ltd., Canada.
- Mostafa, Mohamed Abdel Kerim, B.Sc., A.R.C.S.T., Ph.D., Assistant Lecturer, Royal College of Science and Technology, Glasgow.
- Mullaly, Richard Francis, M.Sc., Ph.D., Research Officer, C.S.I.R.O., Chippendale, New South Wales, Australia.
- Sahasrabudhe, Padmakar Waman, M.Sc., Research Assistant, Imperial College of Science and Technology, London.
- Selwa, Tadeusz, B.Sc., Technical Officer, Imperial Chemical Industries Ltd., Northwich, Cheshire.
- Sundara, Rao Ramayarapu, D.Sc., Lecturer, The Indian Institute of Science, Bangalore, India.
- *Thomas, Kenneth, B.Sc., Senior Scientific Officer, National Physical Laboratory, Teddington, Middx.
- *Tolliday, Joan Margaret, M.A., Technical Officer, Imperial Chemical Industries Ltd., Akers Research Laboratories, Welwyn, Herts.
- Walker, Laurence Arthur, B.Sc., Senior Research Engineer, University of Nottingham.
- Westerman, Albert, B.Sc., Ph.D., Laboratory Manager, Geo. Bray & Co. Ltd., Leeds.

Wood, Ronald, Principal Scientific Officer, U.K. Atomic Energy Authority, Aldermaston, Berks.

GRADUATES

- *Bowman, Gordon George, M.Sc., Research Student, University of Queensland.
- Clulow, Elaine Elizabeth, B.Sc., Technical Officer, British Cotton Industry Research Association, Didsbury, Manchester.
- Duck, George William, Graduate Apprentice, The English Electric Co. Ltd., Luton, Beds.
- Falkingham, John Alan, B.Sc., Scientific Officer, British Railways Research Department, Derby.
- Gentle, Jack Ralph, B.Sc., Engineer, Sperry Gyroscope Co. Ltd., Feltham, Middx.
- Haines, Alan William, B.Sc., Assistant Research and Development Engineer, Vickers-Armstrongs (Engineers) Ltd., Crayford, Kent.
- Hewinson, Vincent Keith, B.Sc., Technical Officer, British Nylon Spinners Ltd., Pontypool, Mon.
- James, William Graham Gunter, M.A., Physics Master, Newport High School for Boys, Newport, Mon.
- *Manchester, Leslie, Student, Department of Education, University of Nottingham.
- Marriage, Allan John, B.Sc., Scientific Staff, The General Electric Co. Ltd., Wembley, Middx.
- Maycock, John, B.Sc., Physicist, Hawker Siddeley Nuclear Power Co. Ltd., Langley, Bucks.
- Millard, Anthony John, B.Sc., Research Physicist, Westinghouse Brake and Signal Co. Ltd., London.
- Ninham, Barry William, B.Sc., Graduate Assistant, University of Maryland, U.S.A.
- Smith, Alan Walter, B.Sc., Section Leader, Armstrong Siddeley Motors Ltd., Coventry, Warwicks.
- Smith, Robert Lionel, B.Sc., Assistant Research Engineer, T. A. Parsons & Co. Ltd., Newcastle-on-Tyne.
- Thompson, David Stuart, B.Sc., Research Student, University of Leeds.
- *Upton, Philip Scott, B.Sc., Technical Assistant, University of Queensland.
- Watson, Kenneth John, B.Sc., Research Student, University of Western Australia.
- Wood, Colin Francis McDermot, B.Sc., Research Student, King's College, London.

Twelve students and three subscribers were also elected.

The Institute's Journals

PRINCIPAL CONTENTS OF THE OCTOBER, 1958, ISSUES

Journal of Scientific Instruments: Volume 35, No. 10

ORIGINAL CONTRIBUTIONS

A decade of stable resistors for calibration of the Smith resistance thermometry bridge (type 3). By G. C. Lowenthal, A.Inst.P., and R. G. Ackland, A.Inst.P.

A decade of highly stable 10Ω resistors employing a new method of construction is described. The bare manganin wires are wound on Pyrex glass tubes which are assembled in such a way as to permit annealing (at 420°C) and pickling of the whole assembly. The resistors are adjusted after being annealed, and are then pickled and sealed into a Pyrex glass envelope without being further disturbed. The lead resistance characteristics demanded by the balance equation for the Smith bridge (type 3) are discussed, and the calibration and use of the decade for checking the bridge are described.

Computing plates. By J. de Meulenaer.

A simple appliance is described by the aid of which a number can be set mechanically on the keyboard of a desk calculator any number of times.

An electrostatic-magnetic alinement section for the electron microscope. By M. E. Haine, F.Inst.P., A. W. Agar, F.Inst.P., and T. Mulvey.

A compact electron beam shift and tilt system, using electric and magnetic fields in place of the normal mechanical system, is described. This improves mechanical stability and permits reflexion electron microscopy up to angles of beam tilt of 20° .

The preparation of single-crystal ingots of silicon by the pulling technique. By E. Billig, F.Inst.P., and D. B. Gasson.

The construction and operation of a laboratory furnace for preparing monocrystals of silicon by the pulling technique are described. The design allows for close observation of the growth front of the ingot during its preparation. It has been found possible to assess the quality of high-grade silicon, and also to obtain an indication of the concentration of dominant impurities responsible for the measured resistivity by comparison with computed distribution curves.

The sensitivity of low-frequency valve amplifiers for electromyography. By A. Nightingale, F.Inst.P.

An analysis of the required sensitivity of electromy-

graph amplifiers is given in terms of the source impedance. Possible sources of noise in low-frequency amplifiers are discussed and estimates of their magnitudes made on the basis of previous published figures. An account is given of an experimental comparison between valve types, and an investigation of the effect of operating conditions; the noise depends on both the grid bias and the anode current. Spectral analyses are given of the noise from selected valves in the range 2 to 16,000 c/s. Persistent selection and good fortune have brought to light a pair of valves with a noise level lower than any previously reported in this frequency range (as far as the author is aware). Finally it is shown how, under certain conditions, the noise performance can be improved by means of an input transformer.

An alternating-beam spectrophotometer. By R. V. Hesketh, A.Inst.P.

An alternating-beam system has been added to a Unicam type SP.500 spectrophotometer for work over the wavelength range 2000–10,000 Å. In the visible spectrum a change of optical density of 0.0007 may be detected with an illumination intensity of 10^8 quanta per second and a response time of twenty seconds. The additional system is of simple construction and provides a means of measuring optical absorptions when the presence of other radiation prohibits the use of a single-beam instrument.

An electrodynamic magnetic field gradiometer employing a microvibration technique. By Y. L. Yousef, and H. Mikhail.

A simple arrangement is described for measuring magnetic field inhomogeneity in any direction to an accuracy of at least 10^{-3} G/cm. The essential part is a very small coil fed by a low frequency a.c. so as to possess an alternating moment and is held, in the (non-homogeneous) magnetic field under test, at the end of a clamped-free elastic reed. When the coil axis is set parallel to the lines of force, it will experience an alternating electrodynamic force (proportional to the field gradient) having a component parallel to the field direction and two other components across the field direction. The coil can follow one or the other of these forces according to the way in which it is constrained to move. The problem thus resolves itself into microvibration measurement. A capacity pick-up circuit is used for this purpose.

British Journal of Applied Physics: Volume 9, No. 10

The influence of shear and rotatory inertia on the free flexural vibration of wooden beams.

By R. F. S. Hearmon, F.Inst.P.

The existence of shear and rotatory inertia effects leads to a reduction in the frequency of flexural vibration of beams as compared with the frequencies predicted by the simple Rayleigh treatment. Tables and graphs, based on the Timoshenko-Goens theory, are given to facilitate the estimation of the correction factor in the case of free-free beams. Experiments are described in which the frequencies of wooden beams are measured up to the 16th mode, and a least-squares method is described for analysing the results. Effects introduced by the anisotropic nature of wood are also investigated and discussed.

Photoelastic properties of plasticised poly-methyl methacrylate in the glassy state. By J. H. Lamble and E. S. Dahmouch.

The stress-optical coefficient of polymethyl methacrylate plasticized with dibutyl phthalate varies linearly from -4.55 Brewsters (18°C) for the unplasticized polymer to $+4.4$ Brewsters for the polymer plasticized with 20% by weight dibutyl phthalate, being zero when the percentage of this plasticizer is about ten. Another plasticizer, polyethylene glycol, when used in the same proportion by weight as for dibutyl phthalate, has a much smaller influence on the stress-optical coefficient. Optical creep reduces algebraically the value of the stress-optical coefficients. The influence of the proportion of the plasticizer on the refractive index and the mechanical properties of the plasticized polymers is also studied.

The theory of ballast tubes or barretters. By R. O. Jenkins, F.Inst.P.

The theory is based on a simple graphical method of solving the equation of thermal equilibrium of an electrically heated wire in a gas-filled enclosure. The results account for the main operating characteristics and have accurately predicted the ratings of various low voltage barretters. It is also shown why, in practice, barretters have always consisted of an iron wire in hydrogen.

The bistable behaviour of the magnetic transducer. By E. H. Frei, S. Shtrikman and D. Treves.

It is already well-known that the second harmonic magnetic transducer has instability regions. It has been found experimentally that in each region two modes of output current exist, differing only by the phase, which these currents have with respect to the exciting voltage. Under suitable parameters and excitation conditions, the transducer will jump from one mode of operation to the other, whenever the exciting current is modulated with a negative pulse. It therefore operates like a bistable element.

Proportional counters in X-ray spectro-chemical analysis. By T. Mulvey and A. J. Campbell.

Proportional counters have been used as spectro-

meters in experiments in nuclear physics for some time, but their general application to problems of X-ray analysis has been delayed partly for technical reasons and partly through lack of information. The present report reviews existing theories on the proportional counter in order to determine the fundamental limits of resolving power when used as a spectrometer for light elements such as magnesium. A survey of experimental results indicates that only a slight further improvement in performance is required to enable proportional counters to analyse adjacent elements such as magnesium and aluminium, thus allowing one to dispense with an analysing crystal.

The cleaning of glass in a glow discharge. By L. Holland, F.Inst.P.

An investigation into the glow discharge cleaning of glass in kinetic vacuum systems is described. The cleanliness of the treated glasses is assessed by their coefficient of friction μ , freedom from optical absorption and wetting characteristics. Glasses bombarded by high energy electrons from the cathode dark space in the presence of hydrocarbon vapours are coated with organic layers, whereas glasses bombarded in the positive column are cleaned. Deposits formed in hydrocarbon vapours have a value of $\mu = 0.3$ and cannot be wetted, whereas those formed in silicone vapour are wettable and have a value of $\mu = 0.6$. An electrode system is described for use in evaporation plant in which the high energy electrons traversing the cathode dark space are prevented from bombarding the glass. Random bombardment by positive ions and neutral molecules in air, A , N_2 , H_2 and O_2 produces clean glass with $\mu = 0.7 - 0.9$. The contamination of the cleaned surfaces by hydrocarbon and silicone molecules is discussed. Freshly deposited silica films and glass surfaces prepared by fracture in vacuo become contaminated by strongly adsorbed silicone molecules, whereas clean aged surfaces of glass and silica are not contaminated because the cations are screened by OH-ions.

Structure-cell data and expansion coefficients of bismuth telluride. By M. H. Francombe, A.Inst.P.

Accurate measurements of the structure-cell parameters of bismuth telluride, Bi_2Te_3 , have been made using annealed powders and etched rods cut from single-crystal ingots. Previously reported anomalies in the X-ray powder intensity data are found to originate entirely in preferred orientation of the crystallites.

A study of the thermal expansion of the unit cell over the temperature range -195 to 400°C has revealed a marked anisotropy between the axial expansion coefficients, that for the c axis (22.2×10^{-6} per $^\circ\text{C}$ at 20°C) being almost twice that for the a axis (12.9×10^{-6}). Near 200°C changes occur in both the principal axial expansions, comparable with those observed at low temperatures in certain hexagonal metal structures.

CENTRAL ELECTRICITY GENERATING
BOARD

ASSISTANT ENGINEERS

Applications are invited for the appointment of assistant engineers to work in the Research Laboratories at Leatherhead, Surrey.

The selected candidates will be required to work on problems associated with conventional and nuclear power stations. Present investigations concern heat transfer in nuclear fuel elements and heat exchangers, electrostatic precipitators, cooling towers, and boiler feed pumps.

Candidates for senior vacancies should have an honours degree with previous research experience: for other vacancies a pass degree or H.N.C. with appropriate experience would be acceptable, but importance is attached to ability to apply fundamental knowledge.

The salary for these appointments will be on a scale within the range £350 - £1,510 p.a., according to duties and responsibilities of the post. Application forms from I. G. Ellis, Personnel Officer, Central Electricity Generating Board, 24-30 Holborn, London, E.C.1, to be returned by September 30, 1958. Envelopes should be marked "Confidential—Ref. PB/262."

PLASTICS TECHNOLOGIST (preferably physicist or engineer) is required in the plastics department of the research organization of a well-known group of companies.

He will work on the applications of specialized plastics to the group's products at laboratories situated in the S.W. outskirts of London.

Applicants, who should be graduates aged about 30, are invited to send full details of qualifications, experience, etc., to Doulton Research Ltd., Basil Green Laboratories, Hanworth Lane, Chertsey, Surrey.

WOOLWICH POLYTECHNIC
LONDON, S.E.18

Applications invited for assistant lecturer, Grade B, in telecommunications and electronics. Candidates should have a degree in electrical engineering or physics and special knowledge or industrial experience of some branch of the subject would be an advantage. Salary scale within £650 - £1,200, commencing salary according to qualifications and experience, plus London Allowance of £36 to £48.

Particulars and application form from Clerk to the Governors, to be returned by October 17, 1958.

THE CEMENTATION COMPANY

The Group which holds a prominent position in the U.K. and overseas in the fields of Mining and Civil Engineering is currently extending its research activities and require a

SENIOR PHYSICIST

with a good honours degree in physics or Mechanical Sciences Tripos to lead physical investigations.

Candidates 28-35, should have wide interests in classical and modern physics and be able to apply this knowledge to practical problems which might embrace electrical physics, vibration, mechanics of cutting, geophysics, measurement of stress and strain, flow of liquids, and suspensions and radioactive techniques. Initiative and sound technical knowledge however are more important than specific experience. A good salary attaches to the post which is pensionable, and assistance can be given with housing.

Applications should be sent to the Chief Research Officer, Cementation Company Ltd., 20 Albert Embankment, London, S.E.11.

THE INSTITUTE OF PHYSICS

47 BELGRAVE SQUARE, LONDON, S.W.1

THE BENEVOLENT FUND

DEED OF COVENANT

For contributors agreeing to subscribe not less than half a guinea annually for seven years, out of income already taxed—whereby the Fund can reclaim the income tax paid for the benefit of the Fund

I, _____
of _____
in the County of _____

HEREBY COVENANT with the Committee of the above mentioned Benevolent Fund, that for a period of seven years from the date hereof, or during my life, whichever period shall be the shorter, I will pay annually to the said Committee such a sum as will, after the deduction of income tax, leave in the hands of the said Committee a net sum of £ _____, such sum to be paid from my general fund of taxed income so that I shall receive no personal or private benefit in either of the said periods from the said sum, or any part thereof.

DATED THIS _____ day of _____ 19 _____

SIGNED, SEALED AND DELIVERED

by the above-named _____
in the presence of: _____

(Signature) _____

Address _____

Occupation _____

**ENGLISH ELECTRIC
VALVE COMPANY
LIMITED**

Chelmsford, Essex

CAMERA TUBE RESEARCH

Applications are invited from men with a Ph.D. or good Honours Degree who would like to join a new research team working on Television Camera Tubes and other Photoelectronic devices. Experience in this field is not essential but candidates must have a sound basic knowledge of photoconductivity, solid state physics or physical chemistry. Practical experience in these fields, or in vacuum technology would be valuable. Please write giving full details to Department C.P.S., Marconi House, Strand, London, W.C.2, quoting reference PB 1506R.

PHYSICIST

WORK ON ELECTRICAL CONTACTS

**PHYSICIST or GENERAL
SCIENTIST**

of graduate standard required for research and development on electrical contacts.

The work will entail study of light and medium current contacts, formation of corrosion films, metallic diffusion, microphonic noise, contact resistance, etc.

Encouragement will be given to original ideas and the appointment will enable a young graduate of one or two year industrial experience to become a specialist to one of the largest users of electrical contacts.

The organization is located in S.W. Lancs., and the position would be on the established staff with five-day week, including contributory Pension Fund, and usual amenities.

Please give full details of education and experience, and approximate salary sought to Personnel Manager, Automatic Telephone and Electric Co. Ltd., Edge Lane, Liverpool, 7.

Appointments Vacant

The inclusion of particulars of a vacancy must not be taken to imply that the Institute necessarily approves of the terms offered or that might be offered. Candidates should satisfy themselves that these are satisfactory, and they may always refer to the Institute for advice.

FERRANTI LIMITED, HOLLINWOOD, LANCs.

has a vacancy in the non-destructive testing laboratory for a Technical Assistant to carry out non-routine investigational work and assist in the general work of the laboratory involving the use of X-ray equipment, radioactive isotopes, crack-detecting equipment, etc. An honours degree in Physics or equivalent qualification is desirable. This appointment carries a salary fully commensurate with qualifications and experience. The company operates a Staff Pension Scheme and an Insurance Scheme for dependents. Forms of application can be obtained from T. J. Lunt, Staff Manager, Ferranti Ltd., Hollinwood, Lancs. Please quote reference IWR.

SIR JOHN CASS COLLEGE

Jewry Street, London, E.C.3

DEPARTMENT OF PHYSICS

The Governors invite applications for the post of Lecturer in Physics.

Candidates are expected to have qualifications enabling them to take an effective part in the work of preparing students for Special and General degrees of the University of London. Ability to undertake research is desirable. Appointment to date from January 1, 1959, or as soon as possible thereafter. Salary £1,236 × £30 - £1,398 for men. Further particulars and form of application may be obtained from the Secretary.

UNIVERSITY COLLEGE OF NORTH STAFFORDSHIRE

Man required for construction and repair of instruments and apparatus for physics research and advanced teaching. Salary within range £420 - £570. Applicants should preferably have had experience in making of small mechanisms; a general knowledge of scientific apparatus would be an advantage. Applications as soon as possible by letter, stating age, qualifications and experience, with particulars of two referees, to Professor of Physics, University College, Keele, Staffs., from whom further particulars may be obtained.

PHYSICIST for Warp Knitting Research. The British Rayon Research Association requires a physicist to take part in research on warp knitting. The work will involve (a) a study of the mechanical properties of warp knitted fabrics, and the relation between these properties and geometrical structure; or (b) investigations into the mechanism of warp knitting machines, and the development of instruments to obtain information about them; or both (a) and (b); depending on the bent of the person appointed. Candidates should have a good honours degree, but experience in the field of knitting is not essential. Salary according to age and experience. Apply to the Secretary, British Rayon Research Association, Heald Green Laboratories, Wythenshawe, Manchester 22, quoting ref. T.7.

PHYSICIST with experience in nuclear radiation measurements and development of electronic instruments required to take charge of Nuclear Engineering Laboratory. This is a senior appointment providing a wide field of interest on Reactor, Hospital and Industrial nucleonic instrumentation. The post is pensionable and carries a salary commensurate with the level of responsibility. Please write, in confidence, to the Chief Engineer and Manager, Nuclear Engineering Division, General Radiological Ltd., 15/18 Clipstone Street, London, W.1.

UNIVERSITY OF LONDON

ROYAL HOLLOWAY COLLEGE

SENIOR RESEARCH ASSISTANT IN PHYSICS

Applications are invited for the post of Senior Research Assistant for a program of work on the magnetic properties of thin films. The appointment is for two years in the first instance. Applicants should be of Ph.D. standard; some experience of electronics is desirable. Salary according to age and experience with F.S.S.U. benefits if required.

Applications, which should include a statement of qualifications and the names of not more than three persons to whom reference may be made, should be sent to the Principal, Royal Holloway College (University of London), Englefield Green, Surrey, as soon as possible.

PHYSICS GRADUATE required for a materials research laboratory situated in South Northants. Applicants should preferably have had some experience in the measurement of the properties of materials at liquid hydrogen/helium temperatures, or alternatively of the properties of semi-conductors. Please apply to the Deputy Research Manager, The Plessey Co. Ltd., Caswell, Towcester, Northants.

THE COLLEGE OF AERONAUTICS

Applications are invited for a Research Fellowship in Metallurgy or Solid State Physics in the Department of Aircraft Materials.

Candidates must possess a good research background and be suitably qualified academically. It would be an advantage if the field of research were related to the behaviour of materials under dynamic stressing. Publication is encouraged and it may be possible to work for a higher degree. Salary in the ranges: Senior Research Fellow £1,000 to £1,200, and Research Fellow £650 to £900 per annum, with superannuation under F.S.S.U. and family allowance. Appointment will be made initially for three years with prospects of continuation. Applications containing full particulars and containing the names of three referees, should be addressed to the Recorder, The College of Aeronautics, Cranfield, Blechley, Bucks.

PHYSICIST (SENIOR SCIENTIFIC OFFICER) required by L.C.C. in Scientific Branch at County Hall for research work on properties of materials and in field of health physics. Good honours degree in physics and general physical experience required with knowledge of radio-chemical equipment. Salary within scale £1,037 - £1,305 according to qualifications and experience. Permanent and pensionable. Application forms from Medical Officer of Health, (DI/A), County Hall, London, S.E.1, by November 18. (2077).

COMMONWEALTH OF AUSTRALIA
DEPARTMENT OF SUPPLY
WEAPONS RESEARCH ESTABLISHMENT
SALISBURY, SOUTH AUSTRALIA

Applications are invited for positions of Scientific and Experimental Officers in the development of Instrumentation for the performance testing of Guided Missiles.

SCIENTIFIC OFFICER GRADE 3 (Several Vacancies)

Duties: Research and development work associated with the performance testing of guided missiles and target aircraft, in the fields of:

- Problems of atmospheric optics associated with the performance of optical equipment under field conditions
- Servo-controlled aerial and camera mounts
- Transducers and allied equipment and techniques
- Telemetry systems
- Electronic and electro-mechanical devices used in the control of pilotless aircraft
- Analogue and digital computers
- Microwave techniques.

Qualifications: Honours degree in physical science, electrical or radio engineering desirable or other academic qualifications and research achievements considered the equivalent. Research experience in the relevant field.

Salary Scale: £1,731 - 1951 (Australian Currency).

SCIENTIFIC OFFICER GRADE 1 (Several Vacancies)

Duties: Research and development associated with the performance testing of guided missiles and target aircraft, in the following fields:

- Radar and allied techniques
- Radio telemetry techniques
- Analogue and digital computers.

Qualifications: Honours degree in physical science, electrical or radio engineering. Research experience would be an advantage.

Salary Scale: £1,326/1,641 (Australian Currency)

EXPERIMENTAL OFFICER GRADE 3 (Several vacancies)
Duties: Experimental and developmental work associated with the performance testing of guided missiles and target aircraft, in the fields of:

- Film processing techniques, including (i) New methods of processing films at present in use; (ii) Processing techniques for new types of film including colour film
- Analogue and digital computers
- Electronic tracking systems
- Radar and allied techniques
- Centimetric transponders and allied techniques associated with the navigation of pilotless aircraft.

Qualifications: Degree or Diploma in physical science, electrical or radio engineering desirable or equivalent academic qualifications, and some experience in the relevant field.

Salary Scale: £1,506/1,686 (Australian Currency).

EXPERIMENTAL OFFICER GRADE 1 (Several Vacancies)

Duties: Experimental and developmental work associated with the performance testing of guided missiles and target aircraft, in the fields of:

- Timing, programming and communication equipment associated with the operation of ground-based airborne cameras
- Specialized tracking mounts for cine cameras
- Measuring instruments associated with the study of atmospheric optics
- Electronic equipment for the control of pilotless aircraft
- Centimetric transponders and allied techniques associated with the navigation of pilotless aircraft
- Analogue and digital computers.

Qualifications: Degree or Diploma in physical science electrical or radio engineering, or other academic qualifications and experience considered the equivalent. Salary Scale: £1,056/1,416 (Australian Currency).

CONDITIONS. Location: Successful applicants will be employed in the laboratories of the Weapons Research Establishment at Salisbury or Woomera. Salisbury is approximately 14 miles from Adelaide.

Housing: Assistance will be given in obtaining housing accommodation for officers and their families.

Travel: First class passages by sea or air will be provided for successful applicants and their families (dependent wife and children) subject to the officer entering into a bond to remain in the Australian Commonwealth Public Service for a period of three years.

Application forms are available from: The Senior Representative (A.V.7), Department of Supply, Australia House, Strand, London, W.C.2, with whom applications should be lodged by November 21, 1958.

BATTERSEA COLLEGE OF TECHNOLOGY
LONDON, S.W.11

Applications are invited from graduates of a British University for two Lectureships in Physics. Preference will be given to specialists in Experimental Microwave Physics or Theoretical Metal Physics. Experience in teaching and/or research essential. Salary: Men, £1,200 by £30 to £1,350 plus London allowance of £36 - £48; Women, slightly lower rising to men's scale by 1961.

Full particulars from the Clerk to the Governing Body, to whom applications should be sent as soon as possible.

MINISTRY OF SUPPLY RESEARCH AND DEVELOPMENT ESTABLISHMENTS, mainly in southern half of England, require (a) Senior Scientific Officers (minimum age 26) and (b) Scientific Officers for work in physics, electronics, electrical or mechanical engineering, applied mathematics, aerodynamics, chemistry or metallurgy. 1st or 2nd-class honours degree or equivalent required and for S.S.O. at least three years postgraduate experience. Starting salary in range (a) £1,130 - £1,330, (b) £595 - £1,050 (male, in provinces). Rates for women reaching equality in 1961. Superannuation under F.S.S.U. Opportunity for those under 32 to complete for established posts. Candidates should indicate fields of work in which interested. At National Gas Turbine Establishment, Pyestock, Hants., houses available for letting to married staff, and opportunities for new graduates to have workshop training. Forms from M.L.N.S. Technical and Scientific Register, K, 26 King Street, London, S.W.1. (Quote A.300/8A).